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RESEARCH ARTICLE



# Traditional ecological knowledge in innovation governance: a framework for responsible and just innovation

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## ABSTRACT

Change in Traditional Ecological Knowledge (TEK) is not easily understood in terms of Western innovation discourses. In fact, innovations in the sense of modern and growth-oriented technologies are common sources for the erosion of TEK. This article brings together current literatures on TEK and innovation studies in addressing questions about the governance of socio-ecological change. First, we connect TEK to shifting meanings of 'innovation' that emphasize contributions to societal goals rather than economic growth or technological modernization. Second, we situate these shifts in governance frameworks of 'responsible innovation'. Third, we argue that the case for self-determination of traditional communities also identifies limits of integrating TEK with recent innovation discourses. As change in traditional communities is part of a wider political set of struggles about conditions of change and decolonization, debates about innovation require engagement with underlying social justice issues beyond mainstream debates about responsible governance.

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## Introduction

Academic debates about Indigenous, local, and traditional ecological knowledge (IEK, LEK, TEK) often focus on their potential as sources for sustainable innovation. For example, the World Commission on Environment and Development stressed in its seminal report *Our Common Future* that tribal and Indigenous 'lifestyles can offer modern societies many lessons in the management of resources in complex forest, mountain and dryland ecosystems' (WCED 1987, 12). Furthermore, TEK has become widely embraced as a source for innovating domains such as conservation management (Berkes 2012; Gadamus et al. 2015; Kimmerer 2011), sustainable agriculture (Altieri 2004; Cannarella and Piccioni 2011), and responses to climate change (Naess 2013; Nakashima et al. 2012; Pearce et al. 2015). At a more general level, TEK has been characterized as a source for rethinking human relationships with their environments. For example, Wildcat (2010, 9) argues that responses to global challenges require an 'Indigenous

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realism' that demands 'respect for the relationships and relatives that constitute the complex web of life. [This] entails that we, members of humankind, accept our inalienable responsibilities as members of the planet's complex life system.'

This optimism about TEK as a source for innovation can be contrasted with a fundamentally pessimistic discourse about the destruction of biocultural diversity and of the epistemic resources of traditional communities. Reasons for pessimism are diverse and have been meticulously documented in the literature on TEK. Climate change can outpace the ability of TEK to adapt to changing environments (Fernández-Llamazares et al. 2013; Hofmeijer et al. 2013; Salick and Ross 2009; Wildcat 2013). Changing social structures such as the adoption of non-Indigenous languages and lifestyles can accelerate the loss of TEK (Benz et al. 2000; McCarter et al. 2014) and disrupt intergenerational knowledge transmission (Brosi et al. 2007; Hanazaki et al. 2013). Assimilation in market economies can force the abandonment of traditional practices (Gómez-Baggethun and Reyes-García 2013; Saynes-Vásquez et al. 2016; Shephard 2006). Migration can force entire communities to leave the social-ecological contexts in which their knowledge systems are embedded (Atran et al. 2002; Lasisi and Ekpenyong 2011; Nesheim, Dhillon, and Stølen 2006; Pieroni and Vandebroek 2007).

The tension between optimistic discourses about the innovative potentials of TEK and pessimist discourses about the destruction of TEK raises fundamental questions about integrating the concerns of traditional communities into innovation scholarship and governance. While there has been increased recognition of the dynamic character of TEK (Ingold 2000; Fernández-Llamazares et al. 2013; Furusawa 2016; McMillen, Ticktin, and Kihalani Springer 2016; Murphy et al. 2016; Whyte 2016a), innovation in the sense of economic growth and technological modernization is commonly a cause rather than a solution to the erosion of TEK.

This article develops a framework for better representation of TEK in innovation scholarship and governance. The aim of such a framework is to incorporate concerns about ubiquitous socio-ecological change in traditional communities without forcing Western imperatives of innovation on TEK. First, we connect TEK to shifting meanings of innovation that emphasize its contribution to societal goals rather than to economic growth or technological modernization. This reconfiguration of innovation provides important connections to community-centered thinking in TEK and suggests a perspective on change that focuses on alignment with the concerns of local communities.

Second, shifting meanings of innovation have also contributed to the emergence of novel governance frameworks of 'responsible innovation' such as the AIRR-model of anticipation, inclusion, reflexivity, and responsiveness. We argue that an adapted AIRR-model can provide a useful starting point for better incorporating TEK into innovation discourses. Third, we argue that current frameworks of responsible innovation provide helpful resources but also have limitations in negotiations of change in TEK. Responsible innovation has emerged as a governance framework that is primarily implemented by national and supra-national organizations in the 'Global North' such as national funding bodies or the European Commission. In contrast, perspectives on change on TEK require consideration of marginalization and decolonial struggles that broaden the focus beyond 'responsibility' and towards questions of 'social justice' in innovation.

Taken together, these three steps lead to a framework for bringing TEK more directly into debates about 'responsible innovation', and into innovation studies more broadly,

that have been shaped largely by European priorities and concerns (Van der Molen et al. 2019; Von Schomberg 2013), but are being increasingly expanded into the 'Global South' (Doezema et al. 2019; Macnaghten et al. 2014). We conclude by arguing that such an incorporation of TEK does not only advance theoretical debates in innovation studies but also has substantial implications for the governance of science and technology in contexts that affect traditional communities. The point is not to provide governance frameworks for traditional communities who may have well-developed procedures for responding to change and that are very different from frameworks of 'responsible innovation'. Instead, the goal is to contribute to governance frameworks designed for external actors who are impacting on traditional communities in direct ways but who commonly lack the resources for responding adequately to TEK. The livelihoods of traditional communities have become closely entangled with innovation policies at national and supranational levels, from national economic policies to minority representation to the international governance of climate change and natural resource extraction. This entanglement requires a dialogue between innovation studies and TEK, and a reconfiguration of current frameworks of innovation designed to respond to the concerns and priorities of traditional communities.

### Reconceptualizing innovation: from modernization to societal goals

While 'innovation' is an ambiguous term, it is commonly associated with progress through technological modernization and economic growth (Blok and Lemmens 2015; Grunwald 2017; Scott-Smith 2016; Wells 2016). These associations lead straight to the core of tensions between TEK and innovation discourses. While TEK has been widely recognized as dynamic and adapted to change, innovations *in the sense of* technological modernization and economic growth often turn out to be causes rather than solutions to the erosion and destruction of TEK.

One may respond to this tension by rejecting 'innovation' as an organizing concept for discussions of change in TEK. Just as post-development theorists have argued that development discourses are beyond repair (Escobar 2015; Carvajal Burbano et al. 2011; Radcliffe 2015), a post-innovation approach could argue that the notion of innovation is too deeply steeped in a modernist growth paradigm and thus should be replaced *tout court* with conceptual resources that are better equipped to guide debates about change in TEK. Simply eliminating the term 'innovation', however, does not solve the challenge of having to identify positive resources for change in contexts where many traditional communities are threatened in their existence through economic exploitation, ecological destruction, and loss of cultural as well as linguistic diversity. Alternatively, one may seek to reconfigure 'innovation' in a way that does not presuppose a narrow modernist outlook. This section develops the general idea of such an innovation concept while the next sections propose more specific criteria for engaging with issues of responsibility and social justice in TEK innovation.

While innovation presupposes change, not all changes are innovative. Although the notion of innovation has often been used to appeal to economic growth and modernization, the term has also become widely used to articulate alternative visions of change through frameworks such as 'inclusive innovation' (Foster and Heeks 2013; Chataway, Hanlin, and Kaplinsky 2014; Heeks, Foster, and Nugroho 2014), 'responsible innovation'

(Stilgoe, Owen, and Macnaghten 2013; Von Schomberg 2013), and ‘social innovation’ (Datta 2012; Nicholls and Murdock 2012; Tapsell and Woods 2008). The plurality of partly complementary and partly competing specifications has made ‘innovation’ a contested concept (Krause 2013) that is used to articulate heterogeneous perspectives on change.

While current debates about innovation do not converge on one definition, much of the literature treats contributions to societal goals at least as a minimal condition for genuine innovations (e.g. UNICEF 2010; Betts, Bloom, and Omata 2012; Pansera and Martinez 2017), so that change in the context of a specific community qualifies as innovative only if it aligns with the societal goals of that community. If innovation is understood in terms of this minimal condition, economic growth and technological modernization turn out to be neither necessary nor sufficient for innovation. For example, change that contributes to societal goals can be realized through what Pansera and Owen (2016) call ‘innovation for degrowth’. As Pansera and Owen show in the context of the Indian state of Kerala, degrowth strategies have been embraced as contributing to a variety of societal goals, from addressing poverty to increasing scientific literacy. Of course, examples such as the innovation for degrowth literature do not imply that innovation is generally incompatible with economic growth, and there can be strong arguments that a particular growth strategy contributes to core societal goals such as better access to healthcare and nutrition. However, economic growth should not be treated as a constitutive part of the notion of innovation.

Furthermore, the minimal condition of aligning change with societal goals distinguishes innovation not only from economic growth but also from technological modernization. In the context of TEK, the growing literature on knowledge revitalization (Big-Canoe and Richmond 2014; Fenelon and Hall 2008; McCarty, Romero, and Zepeda 2006) provides manifold examples of social innovations that are not about the introduction of novel technologies but concerned with the reconfiguration of cultural and social dynamics. One clear example of this are novel educational strategies that are ‘drawing on the past to meet the future’ (Turner and Spalding 2013) by integrating TEK in formal schooling (Burford et al. 2012; McCarty, Romero, and Zepeda 2007; Van Eijck and Wolff-Michael 2007) rather than by introducing novel technologies. Again, the observation that social innovation does not require technological modernization should not be misunderstood as the claim that innovations never involve the introduction of novel and modern technologies. Instead, the point is that technological modernization should not be treated as a constitutive part of the notion of innovation.

Conceptualizations of innovation that aim beyond modernization and growth provide opportunities for a more fruitful dialogue between TEK and innovation studies. This does not mean, however, that critical approaches in innovation studies translate entirely into contexts of TEK. Instead, TEK debates also provide resources for expanding and rethinking what ‘societal goals’ can mean. First, holders of TEK are commonly members of socially marginalized groups whose goals do not align with the majority at the level of the nation state. Community-based perspectives, therefore, emphasize the need to move beyond national conceptualizations of ‘societal goals’ towards a recognition of multiple scales (see section ‘Scales of Representation’). Second, community-based perspectives in TEK can also challenge innovation studies to rethink the kind of actors that are considered when thinking about ‘societal goals’. For example, TEK often includes non-human actors

into its conceptualizations of communities (Kirksey 2017; Miller 2019; Wright 2018) and therefore requires a much broader conceptualization of ‘societal goals’ than the exclusive focus on humans that predominates in many Western innovation discourses (Bovenkerk and Keulartz 2016).

### From concepts to governance: responsible innovation

A reconfiguration of ‘innovation’ in terms of societal and community-based goals, rather than growth and modernization, shows that there does not need to be an intrinsic conflict between innovation and TEK. For example, the revitalization of TEK can itself constitute an innovation insofar as it leads to novel practices that support the goals of a community. The abstract point of conceptual compatibility between ‘innovation’ and TEK, however, does not answer how to align innovation governance and community-based goals in practice. Given that many alleged innovation processes contribute to the erosion of TEK, a merely conceptual discussion of ‘innovation’ would miss the actual challenge of intervening in change processes to align them with the goals of traditional communities.

In recent years, ‘responsible innovation’ has emerged as an increasingly influential governance framework for aligning change process with societal goals (Von Schomberg 2013; Stilgoe, Owen, and Macnaghten 2013). While responsible innovation departs from a conceptual reconfiguration of ‘innovation’, it also aims to provide concrete governance tools for actually structuring innovation processes responsibly. The aim of this section is to explore the suitability of these governance frameworks for engagement with TEK. More specifically, we focus on Stilgoe, Owen, and Macnaghten’s (2013) AIRR dimensions of (A) anticipation, (I) inclusion, (R) reflexivity, and (R) responsiveness. Roughly, the AIRR framework assumes that responsible innovation anticipates multiple effects of change on the basis of inclusive deliberation that fosters reflexivity about background assumptions and responds to concerns, interests, and values of diverse stakeholders.

While AIRR has been widely adopted as a framework of responsible governance of innovation, it is not obvious how well it translates into contexts of TEK. Stilgoe, Owen, and Macnaghten (2013) develop their AIRR dimensions in the context of British debates about the geoengineering project *Stratospheric Particle Injection for Climate Engineering* (SPICE) that explored the possibility of mitigating global warming through the injection of large amounts of particles in the stratosphere. Much of the literature on responsible innovation has been developed through similar case studies of national controversies about emerging technologies in Europe and North America. As Macnaghten et al. (2014, 192) acknowledge, the debate about responsible innovation, therefore, comes with the risk of ‘foisting a concept that has to date had a rather Northern (and in policy terms European) atmosphere on the global South with little regard for its context and for the assumptions that [responsible innovation] as a Northern political artifact brings.’

While there is a quickly growing literature on responsible innovation beyond Europe (De Campos et al. 2017; Fisher 2016; De Hoop, Pols, and Romijn 2016; Monteiro and Rajão 2017; Vasen 2017; Wong 2016; Doezenia et al. 2019), it remains far from clear how established frameworks such as AIRR should be adapted in globally heterogeneous cultural and political conditions. Contexts of TEK provide some of the clearest examples

of these limitations as they involve negotiations of change that differ strongly from the ‘speculative world of emerging technologies’ (Hilgartner and Lewenstein 2004) that have dominated debates about responsible innovation in European and North-American contexts.

Rather than simply applying existing formulations of responsible innovation to the context of TEK, an adequate discussion will have to adapt and specify tools such as the four AIRR dimensions to issues of change in TEK. Winner’s (1989) philosophy of technology provides a helpful starting point for developing such specifications by introducing technologies as ‘forms of life’ with transformative implications for cultural and social configurations. As Winner points out, technologies need to be addressed ‘not merely [as] aids to human activity, but also [as] powerful forces acting to reshape that activity and its meaning’ (1989, 6). Rather than thinking of such transformations as side effects, a framework of technologies as ‘forms of life’ puts them at the center of thinking about innovation in TEK. For example, the introduction of a novel crop in a local context may be motivated by the goal to create a novel source of income but its potential to reshape a community – such as its farming technologies, work routines, land distribution, income distribution, social stratification, nutrition, relation to local biodiversity, relation to cultural heritage, etc. – would be fundamentally misunderstood as mere ‘side effects’. Furthermore, Winner notes that understanding the mechanics of a technology is different from understanding its effects as a form of life. For example, detailed scientific expertise about a new crop may be sufficient to assess risks in a narrow sense such as vulnerability to droughts but is certainly not sufficient to anticipate how an introduction of this crop would transform a local community.

While Winner develops his account as a philosophy of technology, it can also be extended to include social innovations that are not technological in a narrow sense. For example, ‘fair trade’ is commonly mentioned as a case of a social innovation (Haight 2011; Huybrechts and Defourny 2008; Phills, Deiglmeier, and Miller 2008) that shows how the development of novel practices can affect not only economic transactions but reshape activities such as labor and consumption in unexpected ways (Naylor 2014; Raynolds 2014).

Thinking of technologies and social innovations as ‘forms of life’ helps to shift the focus from narrowly defined effects and risks of innovations towards their wider and often highly complex roles in adopting communities. As the following sections illustrate, this wider focus provides resources for developing robust interpretations of the AIRR dimensions that engage with the transformative effects of innovations as ‘forms of life’ through anticipation, reflexivity, inclusion, and responsiveness.

## **Anticipation**

Any attempt to anticipate the effects of innovations is fraught with epistemic challenges (Guston 2014). Technology assessment has a long history of managing anticipatory challenges by employing narrow notions of risk that greatly reduce the number of relevant variables. In the context of genetically modified organisms, for example, narrow notions of risk are deeply sedimented in regulatory cultures and policies which assume that ‘the key criterion mediating the release of GMOs into the environment should be a case-by-case risk assessment of impacts on human health and the environment’



(Macnaghten and Carro-Ripalda 2015, 12; see also Busch 2011, 280–286; Irwin 2006; Lee 2009).

In contrast, engagement with GM crops as forms of life greatly increases complexity by requiring anticipation of a large number of effects that can point in different directions (Chaturvedi et al. 2012; Hicks 2017; Macnaghten and Carro-Ripalda 2015). On the one hand, positive effects of GM crops are widely emphasized in well-known case studies. For example, ‘golden rice’ has been hailed for its potential in addressing vitamin A deficiency (Wesseler and Zilberman 2014; Potrykus 2017) and Bt cotton has been embraced as generating ‘higher yields, lower pesticide use, less labour for pesticide application and substantially higher gross margins per hectare’ (Bennett, Morse, and Ismael 2006). On the other hand, a focus on technologies as forms of life also brings into focus effects on biocultural diversity and social structure that have received less attention in the literature. As a recent review of social impact studies by Fischer et al. (2015, 8598) points out: ‘Economic impact studies currently dominate the literature and mainly report that GM crops provide economic benefits for farmers. Other social impacts are less well studied, but present a more complex picture.’

Neglecting wider effects beyond biosafety and economic impact is especially problematic in the context of TEK where the introduction of GM crops can introduce a complex assemblage of entities with novel forms of life arising from new seed providers, new machines and fertilizers, new work routines, new markets, new relationships between people and land, and so on. Debates about change in TEK therefore require a very robust notion of anticipation that considers safety risks and economic impact but also other factors such as food sovereignty, conservation of biocultural diversity, work organization, and social structures of communities more generally. Aiming for such a robust form of anticipation also means that debates about change in TEK face unique epistemic challenges. This is not only because of the quantitative increase in the number of considered effects but also because of the qualitative difficulty of anticipating wider effects of technologies as forms of life.

## **Reflexivity**

Not only anticipation but also reflexivity comes with unique challenges in the context of TEK. In its most general form, reflexivity in responsible innovation ‘means holding a mirror up to one’s own activities, commitments and assumptions, being aware of the limits of knowledge and being mindful that a particular framing of an issue may not be universally held’ (Stilgoe, Owen, and Macnaghten 2013, 1571). Stilgoe et al.’s emphasis of reflexivity can be situated in a wider tradition of science and technology studies that has criticized deficit models of public distrust in emerging technologies (Jasanoff, Hurlbut, and Saha 2015; Wynne 2001). Rather than interpreting public distrust as a simple expression of ignorance towards relevant facts, this literature emphasizes the need to learn from the possibility of competing framings that are driven by different concerns and priorities.

Public controversies about emerging technologies from genetic engineering and robotics to fracking and geoengineering provide rich resources for illustrating the difficulty of maintaining reflexivity in negotiations between heterogeneous actors with very different concerns and sociocultural positions and orientations, often in incomplete



forms of articulation. The context of TEK further increases the epistemic demands of reflexivity at least for Western actors who have to step away from their own perspective in engaging with the concerns and sociocultural positions of holders of TEK.

Nadasdy's (1999, 2003) work on the 'politics of TEK' provides an influential and cautionary tale about failures of reflexivity even in well-meaning attempts to integrate TEK with Western conservation biology. Nadasdy focuses on the decline of the Dall sheep population in the Southwest Yukon Territory that motivated attempts to formulate a new conservation strategy by bringing diverse stakeholders together. However, the involvement of members of the Kluane First Nation did not lead to a mutually beneficial knowledge integration but rather to disagreements and tensions both about the analysis of the problem and potential responses. For example, Nadasdy discusses the case of a proposed hunting regulation for Dall sheep that would have allowed big game hunting but restricted it to shooting of full curl rams. Western scientists and resource managers argued that such a practice would not destabilize the local sheep population while keeping an important revenue stream open. Kluane elders disagreed partly on methodological and partly on moral grounds. First, Kluane evidence from hunting experience and inter-generational stories of sheep populations suggested a much more dramatic decline that was postulated by Western scientists. Second, objections not only concerned the development of population size but also the ethics of shooting full curl rams: 'One person specifically likened it to killing off all the elders in the community; though the actual number of people killed might not be great, the damage to the community in terms of knowledge and social reproduction would be incalculable' (Nadasdy 1999, 8).

Nadasdy's case study illustrates the challenges of cultivating reflexivity when background beliefs and attitudes of scientists and policy-makers strongly diverge from those of the holders of TEK. In these situations, an abstract commitment to knowledge integration and engagement with viable alternatives is not sufficient. Instead, a core challenge for practicing reflexivity in the context of TEK is to actually understand alternatives and how they become viable in the light of diverging methodologies, ontologies, and values. In this sense, both Ludwig and El-Hani (forthcoming) as well as Tengö et al. (2017) argue for the need to move beyond the imperative of integration and to negotiate change despite deep differences or even partial incommensurabilities of knowledge systems.

### ***Inclusion and responsiveness***

Anticipation and reflexivity come with unique epistemic challenges in the context of TEK. Anticipating effects of innovations in TEK requires consideration of how they function as 'forms of life' with the potential to fundamentally reshape practices and meaning in local communities. Furthermore, engagement with such transformations requires deep reflexivity that takes alternative framings seriously even when they are grounded in cross-culturally contrasting methodologies, ontologies, and values (Cajete 2000; Ludwig 2016; Smith 2013).

Focusing on the dimension of inclusion in AIRR provides one potential strategy of addressing these issues. Holders of TEK tend to possess the most developed expertise for meeting anticipatory and reflexive challenges as they have a much more detailed understanding of their communities and knowledge systems (Ludwig 2017; Byskov

**Table 1.** Attempts to implement responsible innovation in TEK face a number of distinctive challenges.

AIRR-Dimension	Epistemic and Political Challenges of Implementing AIRR in TEK
Anticipation	Innovations constitute ‘forms of life’ that have the potential to fundamentally transform practices and meaning in TEK.
Reflexivity	A critical self-reflective attitude in cross-cultural contexts requires serious engagement with diverging methodologies, ontologies, and values.
Inclusion	The anticipatory and reflexive challenges of innovation in TEK require the expertise and substantive inclusion of local communities.
Responsiveness	Overcoming marginalization of holders of TEK requires a commitment to responsiveness in the light of deep cultural differences.

2017). And indeed, local expertise has become widely reflected in development studies and other fields that increasingly emphasize co-creation in multi-stakeholder ‘innovation networks’ (Klerkx, Van Mierlo, and Leeuwis 2012; Leeuwis 2013; Prasad 2016; Tisenkopfs, Kunda, and Sumane 2014) and in calls to integrate Indigenous and Western scientific knowledge (Fox et al. 2017; Raymond et al. 2010; Weiss, Hamann, and Marsh 2013).

However, a look at the reality of co-creation and multi-stakeholder processes illustrates that an abstract commitment to inclusion is not sufficient. Instead, meaningful inclusion requires responsiveness in the sense of the last of the four AIRR dimensions. Again, recall Nadasdy’s case study of failed integration of Kluane TEK and Western science in the management of Dall sheep. While Kluane were formally included, Nadasdy writes that conservation biologists often ‘did not know how to respond, so they did not respond at all. Elders and hunters who experienced this, however, told me they felt that the biologists were treating them “like children” and ignoring what they had to say’ (2003, 213). Inclusion cannot solve the challenges of cross-cultural divergence without a serious commitment to remain responsive in the light of deep cultural differences and limited understanding.

To sum up, an appropriately specified AIRR framework identifies unique challenges but also applicable criteria for engaging with innovation in TEK. For each of the four AIRR dimensions, the context of TEK creates distinctive epistemic and political challenges (see Table 1). However, a robust application of the AIRR dimensions can also provide helpful resources for engaging with innovation in TEK. While the last section proposed a reconsideration of the concept of innovation, a robust application of anticipation, inclusion, reflexivity, and responsiveness can provide critical tools for identifying harmful forms of change as well as constructive resources for embracing novel solutions that actually contribute to the goals of holders of TEK.

### From responsible to just innovation

The previous sections addressed productive interactions between critical innovation studies and TEK. First, we argued that reconceptualizations of innovation beyond economic growth and technological modernization provide opportunities for thinking about change in TEK in terms of societal and community-based goals. Second, we showed that emerging governance frameworks of responsible innovation such as AIRR can provide helpful resources if they respond to the specific challenges of addressing change in the context of traditional communities.

However, there is also a risk of underestimating the political friction between innovation and TEK discourses in this optimistic picture of relatively seamless integration.

This section addresses underlying tensions that result from the interplay of two factors. First, traditional communities tend to envision futures that strongly diverge from the imaginaries of external governance actors (Bartels et al. 2019; Whyte 2017). Second, traditional communities and external actors are often in very different positions of power to enforce their imaginaries. These unequal political positions make issues of change intimately connected to questions of self-determination and continued decolonial struggles against imperatives of Western development and progress (Escobar 2018; Smith 2013). Responsible innovation is a governance framework that has been largely shaped according to the needs of large European governance actors and therefore often lacks resources for probing deeper into these underlying political issues.

While the lack of a clear ‘politics of responsible innovation’ (Van Oudheusden 2014) has been noted in the wider literature, it is especially pressing in the negotiations of change in traditional communities who confront the imaginaries of mainstream society with different ways of thinking about and articulating futures. It is this context, where we suggest to expand debates about responsible innovation with a notion of just innovation that engages more directly with political theory and questions of social justice in innovation practices.

In outlining a perspective on just innovation, Nancy Fraser’s (2005, 2009) work on global justice provides a helpful framework by specifying three dimensions of justice that can complement Stilgoe, Owen, and Macnaghten’s (2014) four AIRR dimensions of responsibility: Fraser’s first dimension of *distribution* is concerned with economic issues of resources such as ownership of land or access to medical services. The second dimension of *recognition* identifies cultural issues such as recognition of ethnic or sexual identities. The third dimension of *representation* identifies political issues in decision-making processes from voting procedures to the status of minority opinions. Applying these three dimensions of distribution, recognition, and representation (DRR) to innovation discourses through a notion of just innovation reveals interesting similarities but also differences with responsible innovation in the sense of the four dimensions of anticipation, inclusion, reflexivity, and responsiveness (AIRR). This section highlights two differences that we take to be of crucial importance for negotiating change in the context of TEK. First, DRR emphasizes the importance of representation across different scales and the creation of injustice through misrepresentation of affected stakeholders. Second, DRR puts into focus the needs of traditional communities that raise questions about the conditions of change in current economic and political innovation regimes.

### **Scales of representation**

One of the core features of Fraser’s DRR framework is that it allows for explicit discussion of different scales of justice. For example, the distribution of resources can be discussed at the level of a family, a community, a city, a state, a nation, a region, or the entire globe. Fraser’s dimension of *representation* is designed to capture tensions between different scales and the possibility of injustice through misrepresentation that excludes affected stakeholders from decision-making processes.

Questions of representation are crucial for the specification of AIRR dimensions such as reflexivity and inclusion. For example, Stilgoe, Owen, and Macnaghten (2013, 1573) mention various instruments for increasing reflexivity such as consensus conferences,

citizens' juries, and focus groups. Different strategies of representation can give such instruments very different shapes and raise difficult questions about appropriate scales. For example, contested technologies can have global ramifications while being primarily discussed on a national scale and most severely affecting specific communities and social groups. Despite these connections between AIRR and representation, the literature on responsible innovation has relatively little to say about conflicting scales. Instead, many initiatives in responsible innovation are institutionalized top-down through national (e.g. funding bodies) or supra-national (e.g. European Commission) organizations that predetermine the scale of representation. For example, the European Commission's (2012) responsible research and innovation policy clearly states its goal is to 'better align both the [research and innovation] process and its outcomes, with the values, needs and expectations of European society'.

In stark contrast to such predetermined scales in dominant institutionalizations of responsible innovation, struggles over representation are at the core of innovation in TEK. The centrality of representation in TEK reflects a common double burden of being disproportionately affected by change processes while simultaneously being marginalized in their political negotiation. Controversies about environmental justice (Mascarenhas 2007; Powell 2011; Vickery and Hunter 2016) provide a straightforward illustration of this dynamic by showing that Indigenous and other local communities suffer disproportionately from environmental burdens in areas such as resource extraction (e.g. mining, timber) and energy production (e.g. dams, power plants) without having an adequate voice in national or even global policy debates. As Schlosberg and Carruthers (2010, 14) observe, negative effects do not only concern direct hazards for health and livelihoods but also the erosion or outright destruction of TEK:

indigenous demands for environmental justice go beyond distributional equity to emphasize the defense and very functioning of indigenous communities – their ability to continue and reproduce the traditions, practices, cosmologies, and the relationships with nature that tie native peoples to their ancestral lands.

Incorporating these issues in the context of TEK requires an understanding of just innovation that seriously engages with the politics of representation and therefore expands beyond established frameworks of responsible innovation such as AIRR. Many holders of TEK and especially Indigenous movements articulate issues of representation through demands for self-determination (Corntassel 2008). Self-determination can be situated in wider debates about the politics of representation by making a case for local scales in decision-making processes that affect local communities most severely. To illustrate this with a more concrete example, local scales of representation are reflected in governance frameworks of 'free prior and informed consent' (FPIC) that have 'been driven by the global indigenous movement and is tied to concepts of autonomy and self-determination' (Owen and Kemp 2014, 91). Recognition of FPIC in extractive industries (Hanna and Vanclay 2013; MacInnes, Colchester, and Whitmore 2017) and environmental programs such as REDD+ (Mahanty and McDermott 2013; Pham et al. 2015) illustrates how self-determination in the sense of local scales of representation can become a core element of just change and innovation. For example, it is not sufficient that a new mine is determined to be in the national (or even some global) interest but it also needs to be in the interest of the most directly affected local communities. A merely national

application of criteria such as AIRR would be deeply misleading by marginalizing Indigenous and other local communities in negotiation processes and often solidifying environmental injustices through misrepresentation.

### **Conditions of change**

Struggles against misrepresentation in the negotiation of change constitute one important reason for expanding established frameworks of responsible innovation in the sense of AIRR with a notion of just innovation in the sense of DRR. Furthermore, Fraser's framework also provides critical resources for addressing innovation processes through the dimensions of distribution and recognition. Many accounts of responsible innovation including AIRR avoid specific demands regarding distribution and recognition such as specific contributions to poverty reduction, food security, freedom of expression, or minority rights. This does not mean that AIRR is unrelated to these issues as a more anticipatory, inclusive, reflexive, and responsive governance of innovations is also assumed to lead to more just outcomes along dimensions of distribution and recognition.

However, this ideal transition from AIRR to DRR is far from guaranteed in the non-ideal (Valentini 2012) economic and political realities of innovation governance that often continue to marginalize concerns and priorities of traditional communities. Much of the literature on responsible innovation is 'reformist' (Vasen 2017, 98) in the sense that it acknowledges deficits in current innovation dynamics but also assumes that these dynamics can be aligned with societal goals through more responsible (e.g. more anticipatory, inclusive, reflexive, and responsive) procedures. In contrast, controversies about the erosion of TEK often involve fundamental critiques of the very possibility of adequate change under current economic and political conditions. Insofar as global processes such as market integration, climate change, and loss of linguistic diversity undermine the foundations of traditional communities and their knowledge systems, innovation in TEK cannot be achieved by increasing anticipatory, inclusive, reflexive, or responsive capacities of current dynamics and procedures alone.

Whyte's (2017, 155) discussion of Indigenous engagement with climate change in North America provides a powerful illustration of this perspective by addressing the destruction of Indigenous livelihoods through climate change as an 'experience of *déjà vu* given that relocation and displacement are part of the history of colonially-induced environmental changes that harmed Indigenous peoples.' Trying to address responsible innovation independently of wider struggles against climate injustice would, therefore, miss how 'rapid environmental change' is not simply an unfortunate event beyond control but rather driven by a history of destruction of livelihoods from settler colonialism and forced relocation to extractive industries and global climate change. As Whyte shows, Indigenous engagement in the climate justice movement is often driven by emphasis of the incompatibility of globally dominant forms of production and just change for Indigenous peoples. As a result, Indigenous movements often express demands that are fundamentally at odds with current economic and political conditions of change, such as The Mystic Lake Declaration's demand of a 95% reduction of carbon emissions for developed countries by 2050 (Whyte 2016b, 95).

The example of climate injustice illustrates that change in TEK cannot be isolated from wider debates about decolonization and other struggles against marginalization that force

local communities in positions of vulnerability while excluding them from meaningful participation in determining the general conditions of change. While responsible innovation frameworks such as AIRR provide tools for shaping existing dynamics of change, socially desirable change in TEK often challenges the fundamental economic, environmental and political characteristics of these existing dynamics. Addressing these fundamental issues requires to connect innovation discourses to wider debates about social justice in the sense of DRR that provide a deeper analysis of political economy and ecology of change in TEK.

## Conclusion

The aim of this article has been to connect current debates in innovation studies and TEK that engage with socio-ecological change in traditional communities. Our starting point was a reconceptualization of ‘innovation’ that is independent of growth and modernization and instead grounded in the idea of change that aligns with community goals. In aiming for a more applicable account, we related the literature on TEK to the literature on responsible innovation that has emerged from debates on the governance of European science and technology. We argued that the application of frameworks such as AIRR comes with distinct challenges in the context of TEK but also provides relevant insights about the anticipation of effects of innovations as ‘forms of life’ and reflexivity about competing framings in the light of cross-cultural differences of methodologies, ontologies, and values. Finally, we argued that established frameworks of responsible innovation, and in particular the AIRR framework, should be extended to reflect explicitly on just innovation – in the sense of DRR – in order to engage with underlying political issues such as debates about decolonization, self-determination, and the conditions for change. In conclusion, we argue that such an integration of debates about innovation and TEK provides resources both for innovation studies and for practical questions of innovation governance.

First, the article provides a framework for innovation scholars to include more adequate representations of traditional communities as commonly marginalized stakeholders in change processes. While some elements – such as reconceptualizations of ‘innovation’ through community-based goals and AIRR – integrate rather easily with established innovation discourses, the context of TEK raises wider and more fundamental questions about social justice that require substantial expansions of current debates about innovation of the kind as indicated by Fraser’s DRR dimensions.

Second, debates about responsible innovation are not merely intellectual exercises but intended to provide a framework for the governance of innovation processes in practice. Traditional communities are directly affected by innovation governance at national and supra-national levels but dominant frameworks of responsible innovation have not been designed with traditional communities in mind. A framework of both responsible and just innovation can build bridges from TEK to governance by taking the urgency of better policy seriously without neglecting its entanglement with wider social justice issues including struggles for representation and the conditions of change.

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